

Appl. No. 10/017,148  
Amendment and Response dated September 17, 2004  
Reply to Office action of August 4, 2004

### Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

### Listing of Claims

Claim 1 (currently amended) A method of modifying a virtual object stored within a computer, the method comprising the steps of:

- representing a virtual object as a volumetric model;
- converting a subset of the volumetric model into a non-volumetric representation;
- modifying the non-volumetric representation according to a stimulus, thereby simulating a deformation of the virtual object while preserving surface detail; and
- modifying the volumetric model so as to substantially represent the modified non-volumetric representation.

Claim 2 (previously presented) The method of claim 1, wherein modifying the non-volumetric representation according to a stimulus comprises modifying the non-volumetric representation according to a first stimulus and further modifying the non-volumetric representation according to a second succeeding stimulus.

Claim 3 (previously presented) The method of claim 1, wherein modifying the volumetric model comprises a change in shape of the volumetric model.

Claim 4 (previously presented) The method of claim 1, wherein modifying the volumetric model comprises converting a response of the non-volumetric representation to the stimulus into a response of the volumetric model to the stimulus.

Claim 5 (original) The method of claim 1, wherein the subset of the volumetric model is the entire volumetric model.

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Claim 6 (original) The method of claim 1, wherein the subset of the volumetric model is a portion of the volumetric model.

Claim 7 (original) The method of claim 1, wherein the volumetric model comprises voxels.

Claim 8 (original) The method of claim 1, wherein the volumetric model comprises values spaced in a three-dimensional grid.

Claim 9 (previously presented) The method of claim 1, wherein the non-volumetric representation comprises a surface representation.

Claim 10 (previously presented) The method of claim 1, wherein the non-volumetric representation comprises a set-of-triangles representation.

Claim 11 (original) The method of claim 10, wherein the stimulus comprises a weighted displacement function defined on vertices of the set-of-triangles representation.

Claim 12 (previously presented) The method of claim 1, wherein the non-volumetric representation comprises a selected one of a polygon set, a bezier surface, a b-spline surface, a procedural surface, and a NURBS representation.

Claim 13 (cancelled)

Claim 14 (original) The method of claim 1, wherein the stimulus is a stimulus from a user using a haptic interface.

Claim 15 (original) The method of claim 14, wherein the haptic interface is a force feedback interface.

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~~Claim 16 (original)~~ The method of claim 14, wherein the haptic interface has at least three degrees of force feedback.

Claim 17 (original) The method of claim 1, further comprising the step of displaying the virtual object on a computer display.

Claim 18 (previously presented) The method of claim 1, wherein the volumetric model and the non-volumetric representation comprise representations having different numbers of dimensions.

Claim 19 (previously presented) The method of claim 1, wherein the stimulus comprises at least one of a displacement function, a smoothing function, a warping function, a volumetric interference, an areal interference, a result of a simulation, a control point modification, a data re-fitting, and a force.

Claim 20 (previously presented) The method of claim 1, wherein the stimulus is applied to the object in real time.

Claim 21 (previously presented) The method of claim 1, further comprising the steps of:  
transforming the non-volumetric representation into a third representation;  
modifying the third representation in response to an applied stimulus; and  
transforming the modified third representation to a modified volumetric representation.

Claim 22 (original) The method of claim 21, wherein transforming the modified third representation to the modified volumetric representation comprises generating an intermediate modified representation.

Claim 23 (previously presented) The method of claim 1, wherein the stimulus comprises a user motion in at least three-dimensional space.

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Claim 24 (original) The method of claim 1, further comprising applying a feedback force to a user, the feedback force being generally consistent with a geometric shape of a modified virtual object.

Claim 25 (currently amended) A method of modifying a volumetric representation of an object, the method comprising the steps of:

transforming at least a portion of the volumetric representation into a polygonal set representation;

modifying the polygonal set representation, thereby simulating a deformation of the object while preserving surface detail; and

modifying the volumetric representation to substantially represent the modification made to the polygonal set representation.

Claim 26 (original) The method of claim 25, wherein the modification comprises a selected one of a displacement function, a smoothing function, a warping function, a volumetric interference, an areal interference, a result of a simulation, a control point modification, a data re-fitting, and a force.

Claim 27 (currently amended) A method of modifying a volumetric representation of an object, the method comprising the steps of:

transforming at least a portion of the volumetric representation into a surface-based representation;

modifying the surface-based representation, thereby simulating a deformation of the object while preserving surface detail; and

modifying the volumetric representation to substantially represent the modification made to the surface based representation.

Claim 28 (currently amended) A system for modifying a virtual object stored within a computer, the system comprising:

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a representation module that represents a virtual object as a volumetric model;  
a conversion module that converts a subset of the volumetric model into a non-volumetric representation;  
an analytic module that modifies the non-volumetric representation according to a stimulus, thereby simulating a deformation of the virtual object while preserving surface detail; and  
a modification module that modifies the volumetric model so as to substantially represent the modified non-volumetric representation.

Claim 29 (previously presented) The system of claim 28, wherein the analytic module that modifies the non-volumetric representation according to a stimulus comprises an analytic module that modifies the non-volumetric representation according to a first stimulus and further modifies the non-volumetric representation according to a second succeeding stimulus.

Claim 30 (previously presented) The system of claim 28, wherein the modification module that modifies the volumetric model comprises a modification module that changes a shape of the volumetric model.

Claim 31 (previously presented) The system of claim 28, wherein the modification module that modifies the volumetric model comprises a modification module that converts a response of the non-volumetric representation to the stimulus into a response of the volumetric model to the stimulus.

Claim 32 (original) The system of claim 28, wherein the subset of the volumetric model is the entire volumetric model.

Claim 33 (original) The system of claim 28, wherein the subset of the volumetric model is a portion of the volumetric model.

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Claim 34 (original) The system of claim 28, wherein ~~up~~ volumetric model comprises voxels.

Claim 35 (original) The system of claim 28, wherein the volumetric model comprises values spaced in a three-dimensional grid.

Claim 36 (previously presented) The system of claim 28, wherein the non-volumetric representation comprises a surface representation.

Claim 37 (previously presented) The system of claim 28, wherein the non-volumetric representation comprises a set-of-triangles representation.

Claim 38 (original) The system of claim 37, wherein the stimulus comprises a weighted displacement function defined on vertices of the set-of-triangles representation.

Claim 39 (previously presented) The system of claim 28, wherein the non-volumetric representation comprises a selected one of a polygon set, a bezier surface, a b-spline surface, a procedural surface, and a NURBS representation.

Claim 40 (cancelled)

Claim 41 (original) The system of claim 28, wherein the stimulus is a stimulus from a user using a haptic interface.

Claim 42 (original) The system of claim 41, wherein the haptic interface is a force feedback interface.

Claim 43 (original) The system of claim 41, wherein the haptic interface has at least three degrees of force feedback.

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Claim 44 (original) The system of claim 28, further comprising a display module that displays the virtual object on a computer display.

Claim 45 (previously presented) The system of claim 28, wherein the volumetric model and the non-volumetric representation comprise representations having different numbers of dimensions.

Claim 46 (previously presented) The system of claim 28, wherein the stimulus comprises at least one of a displacement function, a smoothing function, a warping function, a volumetric interference, an areal interference, a result of a simulation, a control point modification, a data re-fitting, and a force.

Claim 47 (previously presented) The system of claim 28, wherein the stimulus is applied to the object in real time.

Claim 48 (previously presented) The system of claim 28, further comprising:

- a second transformation module that transforms the non-volumetric representation into a third representation;

- a third modification module that modifies the third representation in response to an applied stimulus; and

- a third transformation module that transforms the modified third representation to a modified volumetric representation.

Claim 49 (original) The system of claim 48, wherein the third transformation module that transforms the modified third representation to the modified volumetric representation comprises a transformation module that generates an intermediate modified representation.

Claim 50 (original) The system of claim 48, wherein at least two of the first, second and third modification modules are the same module.

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~~Claim 51 (original) The system of claim 48, wherein at least two of the first, second and third transformation modules are the same module.~~

Claim 52 (previously presented) The system of claim 28, wherein the stimulus comprises a user motion in at least three-dimensional space.

Claim 53 (original) The system of claim 28, further comprising a force feedback module that applies a feedback force to a user, the feedback force being generally consistent with a geometric shape of a modified virtual object.

Claim 54 (currently amended) A system of modifying a volumetric representation of an object, the system comprising:

- a transformation module that transforms at least a portion of the volumetric representation into a polygonal set representation;

- a first modification module that modifies the polygonal set representation, thereby simulating a deformation of the object while preserving surface detail; and

- a second modification module that modifies the volumetric representation to substantially represent the modification made to the polygonal set representation.

Claim 55 (original) The system of claim 54, wherein a selected one of the modification of the polygonal set representation and the modification of the volumetric representation comprises a selected one of a displacement function, a smoothing function, a warping function, a volumetric interference, an areal interference, a result of a simulation, a control point modification, a data re-fitting, and a force.

Claim 56 (currently amended) A system of modifying a volumetric representation of an object, the system comprising:

- a transformation module that transforms at least a portion of the volumetric representation into a surface-based representation;



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...+ a first modification module that modifies the surface-based representation, thereby  
simulating a deformation of the object while preserving surface detail; and  
a second modification module that modifies the volumetric representation to substantially  
represent the modification made to the surface based representation.

Claim 57 (cancelled)

Claim 58 (cancelled)

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